APPENDIX

CONTRIBUTIONS FROM OTHER AUTHORITIES AND AUTHORS

This appendix contains a precis of the papers written by F.C.M. Wegman and others for the Dutch Institute for Road Safety Research (SWOV), and significant points in other replies to my letters. I have included items which are useful in considering or measuring the benefits of safety audit, and also other items which are of interest from the system point of view (and therefore indirectly potentially helping to maximise benefits if the system works well). My own comments are italicised.

1. SWOV Institute for Road Safety Research, The Netherlands

A letter from F. C. M. Wegman and accompanying technical papers was received. He states that while the Netherlands cannot give the information, a European programme 'Safestar' is under way studying safety audit under its local acronym RIA (Road impact assessment). He refers to UK, Danish and French contacts.

Road Impact Assessment is the system being developed and used. A European effort to create a common data base may be instituted. The integration of Environmental impact assessment (EIA) and RIA should lead to an improvement in the quality of the decision making process.

Road Safety Impact Assessment of the road infrastructure takes place on two levels:

'(1) The changes of the distribution of traffic over a certain network due to changes of that network (by using scenario techniques), optimising a network by assessing safety effect due to infrastructural changes in that network and

(2) The changes of design characteristics of roads, by using safety audit techniques, road design may be optimised'

(Note. the above is a combination of two definitions in the papers.)

A 'sustainable system' of roads should be created from the following principles or actions:

'Prevent unintended use of the road infrastructure ie. use that is inappropriate.

Prevent encounters with the implicit risk of high differential speeds ie. large discrepancies in speed, direction and mass at moderate and high speeds.

Prevent insecure or erratic behaviour of road users by enhancing the predicability of the roads course and road user's behaviour on the road.'

(Note: as well as introducing traffic calming implicitly in all of the above, the concept of sustainability gets a boost, which should be a useful selling point in New Zealand. Traffic calming which is introduced as a result of a safety audit not only reduces the incidence of accidents, but gives benefits in the other

advantages of traffic calming ie less noise, less stress, opportunity to use areas for non-traffic purposes)

Tools to optimise network design comprise:

1. Preparing the reference material. This includes categories of roads, lengths of roads per type, road safety indicators per type. These include the number of injuries per kilometre of road, the number of injury accidents per million vehicle kilometres and the number of injuries per accident *(note - presumably he subdivides this into severity of injury, otherwise the statistic is meaningless).* A procedure to compare regional and nation statistics is recommended *(note - for EC this is a need, but in New Zealand, being in effect one region, we could compare cities and districts, or TNZ regions)*

2. The functional boundaries of the region are established and a digitised inventory of all roads needs to be prepared. Obtain or estimate traffic volumes. Locate recorded accidents. *(note: all this seems in hand in New Zealand)*

3. Make an estimation of the traffic volume for the prognosis year; the road safety indicators and try to establish the road safety effects of changes to the network

All these matters are summarised in a 'Road safety impact analyses'. The steps in detail are:

STEP 1: Basic Data

1.1 Categorising a road network

1.2 Road safety indicators per type of road

1.3 Relationship between road safety indicators and traffic volumes

1.4 Distribution of road safety indicators

1.5 Development of road safety indicators

STEP 2: Research area in reference year

1.1 Roads per road type

1.2 Traffic volumes per road type

2.3 Accidents per road type

2.4 Road safety indicators per road type

2.5 Comparing national and regional indicators per road type

STEP 3: Research area in future year

3.1 Road network per road type and estimations of traffic volumes

3.2 Estimation of road safety indicators

3.3 Estimation of road safety effects

3.4 Assessment of road safety impact.

Note. These have been included in full as the above is a system of categorising networks, relating existing factors (in a reference year) and predicting the effects of network changes. As far as I know this is not done formally in New Zealand, though an estimation of future accident savings is often carries out as part of the B/C analysis. It is a small step to take the reference year and predict the number of accident in the future year by subtracting the saving *(and presumably noting the types of accident saved and remaining).*

It would be interesting and useful to have three data and predictions:

1. Present accidents/volume/safety indicators (eg ax/km or ax/ million veh. km)

2. The above data on completion of the scheme as designed

3. The above data on completion of the scheme as amended by safety audit.

The series of papers from F.C.M. Wegman and others continues with a discussion of the process of safety audit which is not particularly applicable here as it reveals shortcomings which I believe our system does not suffer from. However, the definition of the objective gives some insight into a potential indicator:

'The essence of the matter is that the safety auditor is able to arrive at a road design which is simple and easy to recognise for future road users, therefore minimising potential for error.'

On this basis, it should be possible to check both designs and audited designs to see if there are any features which do not comply with the above definition. Presumably compliance with standards does enter into the scene, because if standards (which are reasonable) are complied with, then the road user expects the standard to be used - it is not a surprise.

As matter of interest, the author lists 4 stages of audit:

1. First phase: Feasibility/initial design

2. Second phase: Preliminary design

3. Third Phase: Traffic Signs

4. Fourth Phase: Inspection of the road.

In the next paper the author lists the stages and content of Environmental Impact Assessments (EIA), as being of interest to those considering Safety Audit (he calls RIA). *The chief interest is the emphasis on sustainability which has not, to my knowledge, been considered as an attribute of safety audit.*

The author discusses the relationship between EIA and RIA (once again, to my knowledge not a feature here), and after recommending the contents of the SWOV studies as a starter for RIA, suggests that the advantages and disadvantages of making RIA compulsory be discussed. If Safety Audit has the advantages claimed (and claimed to be demonstrated) then the benefits of making it a compulsory procedure should outweigh the costs. *This is a possible future study which I feel should be made.*

2. Bruce Corben, Monash University, Accident Research Centre

His 'brief thoughts on an approach to the evaluation of safety audit are as follows:

- take a group of road projects and subject them independently to both processes, ie with and without safety auditing;
- identify significant differences in the planning and design outputs of both processes and in the input, capital and recurrent costs of both processes;
- estimate the future crash rate of the unaudited outcomes for each project, based on typical crash rates for roads of similar type;
- estimate the safety consequence of the significant differences, where possible using the results of past evaluations to estimate the crash change). Where there are no past evaluations to draw on, best estimates would need to be made;
- these estimates could then be used to estimate the crash savings due to safety auditing, and the costs of achieving them, enabling some sort of economic evaluation to be carried out.'

He feels that this process applies to the planning and design phases only. *(Note: I'm not so sure about this. If correctable faults which would otherwise have been accident causers are detected and removes, it seems immaterial what phase this takes place.)*

Mr Corben includes extracts from the New South Wales publication Road Environment Safety, and road circular 15 'Road safety in the Planning Process'

A study for the 'NSW Road Safety 2000 Strategic Plan' found "that there was a general lack of awareness of the role of road safety in strategic land use and transport planning. Strategic planning outcomes tended to be more related to environmental, social and economic issues, rather than road safety."

(Note: This seems to be a plea for safety auditing of strategic plans, as well as the network safety audits we are all familiar with. Presumably, to achieve full benefits of safety audit we have to include this issue as well)

Another interesting technique he includes in the quotes from the publication (Produced by Manager: Peter Croft (02) 218 6260) is a sample checklist to determine whether a development has a road accident potential is given:

1. Does the development have either pedestrian or vehicular access on to a main road?

2. Is the development likely to generate more than 500 vehicles per day, on more than 50 occasions per year?

3. Is the development likely to generate substantial volumes of more than 50 pedestrians an hour who my wish to cross a busy road?

4. Do vehicles have to cross lanes of traffic to enter or exit the site?

5. Is there a visibility problem at the site where pedestrians cross or where vehicles enter or exit the site?

6. Are there any existing accident problems in the vicinity?

(Note: I wonder what insubstantial volumes of more than 50 pedestrians per hour look like. Children? Not likely. and 'may' should be replaced by obliged. It should be possible to say where they come from and go to.)

3. Barbara E. Sabey

Miss Sabey refers to a study of minor works in Surrey (which she enclosed). It is claimed that saving one injury accident ($138,000 NZ) will produce a positive economic benefit.

Lothian reports a B/C of 14:1 based on saving $NZ2.5M at a resource cost of $NZ175,000.

She also repeats the NZ apocryphal; figure of 20:1 B/C which is based on UK estimates.

4. Road Safety Audits - an investigation into casualty savings - discussion report - Surrey County Council, UK

240 sites have been or are being audited, the data being entered into a Geographic Information System (GIS) programme called WINGS. Accident data is on the same data base.

38 minor works sites which hade been safety audited and had a two year after period were selected. Comparison sites (38?) which had not been safety audited were selected for comparison purposes.

An average of accidents per year before and after construction was calculated. The yearly averages (for each field) were totalled and the mean for all sites found.

An average of casualties per (injury?) accident was calculated, for the whole County. The average number of casualties per site was determined.

This was done both for sites which had been safety audited and those which had not. The casualty savings per site per year was then found. (presumably the mean of all audited v. non audited sites).

It was found that whereas the saving in casualties per non audited site was 0.26, the saving at audited sites was 1.25 an increased saving of approximately one casualty.

Full tabular details are given, including (non audited) sites where the casualty rate had increased.

It was concluded that the study indicated that accident/casualty savings could be achieved through proper safety audit.

(Notes: No statistical tests were applied. The County intend to continue with more studies, so this point may be considered. They also say that only minor works were considered for either field. However, the sites were chosen at random which gives some confidence in the results. This is the only

documented study to hand which compares audited v. un-audited sites. Clearly the method could be trialed in New Zealand. A data based system based on the LTSA accident package should be prepared).

5. Vic Roads (some indecipherable person for David Anderson)

This reply to my inquiry included several comments about the process which illustrated the difficulties:

1. Safety audit is just one input. The 'benefits' need to be "traded off" against the costs. Was the deficiency noted earlier?

2. Safety auditing is not just concerned with current standards but also desirable safety principles and practices. In the end it is up to the planners designers and managers to make decisions within "the possible". A deficiency may be a desirable objective *(and possibly no more than that? note).*

3. Safety auditing is often a subjective point of view.

4. The safety deficiencies identified through an audit are often difficult to quantify in terms of accident performance.

The measure of safety audit effectiveness therefore needs to be defined.

Whilst Vicroads has not quantified the benefits it is considered that designers and constructors are more aware of safety performance of their project.

(Note: It is hope that this project will throw light on the unknowns such as the savings per fault rectified.. The point about the possible reoccurence of a fault previously identified needs to be taken on board in measuring effectiveness.)

6. Road Directorate, Denmark Ministry of Transport - Lene Herstedt

Safety audit was introduced into Denmark in 1992. The Road Directorate has carried out a two year study of traffic calming including 13 schemes, evaluated by a panel of experts. It has been found that for a 1% increase in costs, a first year rate of return of 100% occurred.

7. Highways Agency, Department of Transport, UK - Peter Borrough

The Transport and Road Research Laboratory has been commissioned to undertake a study of 5 years data with the objective of finding 'the best practice' (whether this is with respect to safety audit or the design of roads is not clear). They will be interested in sharing the results on a reciprocal basis.

(Note. Some of these sources will need to be followed up, particularly the last two above)

M. L. Gadd June 1996

SWOV
Institute for
Road Safety
Research

P.O. Box 170 2260 AD Leidschendam The Netherlands
Duindoorn 32 telephone 31703209323 telefax 31703201261

Mr. M.L. Gadd, C. Eng., MICE, FIPENZ
2/63 Rountree Street
Christchurch 4 New Zealand

Our reference : FW/mgo/966111
Your reference :
Research number :
Subject : Benefits of Safety Audit

Leidschendam, 15 April 1996

Dear Mr. Gadd,

Thank you for your letter dated 13 March 1996 in which you requested factual information on the benefits of safety audits.

I am afraid that I have disappointing news for you since we in the Netherlands cannot give you this information. The present situation is that the SWOV is trying to get the 'road safety impact assessment method' introduced. I have sent Dr. Appleton some information on this method. With regard to the standard safety audits, the RIA also contains reviews on a more strategic level.

We have presented this idea to the European Commission and fairly soon a plan will be worked out in the project 'SAFESTAR'. In this project we will try to bring together the different ideas on audits and RIA's in Europe. Hopefully this will eventually lead to some harmonization. I don't expect results until next year. As far as I know action is being taken not only in England but also in Denmark and France. I would suggest you contact Christian Machu (SETRA, 46, Av. Aristide Briand, F-92223, Bagneux, France) and Lene Herstedt (Danish Road Directorate, Ministry of Transport, Niels Juels Gade 13, DK-1020 Copenhagen K, Denmark).

May I also say that I would be interested in receiving information on this subject from your part of the world.

I suggest you keep in touch.

Yours sincerely,
SWOV Institute for Road Safety Research

F.C.M. Wegman
Research Director

Dr Ian Appleton BRUCE CORBEN – MLS 25/3

Ian Appleton

MONASH UNIVERSITY
ACCIDENT RESEARCH CENTRE

Wellington Road, Clayton 3168
Victoria, Australia

FACSIMILE TRANSMISSION

TO: Mike Gadd
Civil and Transportation Engineer
FAX NO: 64 (3) 348 3710

FROM: Bruce Corben
FAX NO: (61)(3)9905 4363

DATE: 25 March, 1996

Total number of pages (incl. this page) = 6
If there are any difficulties in transmission please telephone (61)(03) 9905 4371

Dear Mike,

Benefits of Safety Audit

Peter Vulcan has asked me to reply to your letter re. the above. I have been in touch with Phil Jordan at VicRoads and Ken Ogden at Monash University, Civil Engineering, as both have had considerable involvement in the Safety Auditing area in Victoria and nationally. While I realise that you know Phil already (and maybe Ken also), both have had more involvement in the concept than I have had of late. Phil intends, therefore, to phone you in the next few days to discuss matters with you.

My brief thoughts on an approach to the evaluation of safety audit are as follows:

- take a group of road projects and subject them independently to both processes, i.e. with and without safety auditing;
- identify significant differences in the planning and design outputs of both processes and in the input, capital and recurrent costs for both processes;
- estimate the future crash rate of the unaudited outcomes for each project, based on typical crash rates for roads of similar type;
- estimate the safety consequences of the significant differences, where possible using the results of past evaluations to estimate the crash changes). Where there are no past evaluations to draw on, best estimates would need to be made;
- these estimates could then be used to estimate the crash savings due to safety auditing, and the costs of achieving them, enabling some sort of economic evaluation to be carried out.

I believe that the above evaluation would be relevant only for the planning and design phases of safety auditing but not for the pre-opening nor operating phases, the latter being less important in my view.

Miss Barbara E. Sabey
ISO, BSc, F.Inst P, FIHT
Road Safety Consultant

17 Knole Wood
Devenish Road
Sunningdale
Berkshire SL5 9QR
Tel: Ascot (01344) 24705

Mr M L Gadd
Civil and Transportation Engineer
2/63 Rountree Street
CHRISTCHURCH 4
NEW ZEALAND

1 April 1996

Dear Mike

Benefits of Safety Audit

It was good to hear from you again. I thought of you when I was on holiday in the North Island in February. Unfortunately I did not get down south this time. I look forward to seeing you and Rae if you come over.

As regards the benefits of safety audit I do not have much to offer. We are in the process of revising the UK Guidelines, the following extract from the draft of which indicates how little we have.

"A 1994 study of minor works in Surrey compared two groups matched for scheme type, one group having been audited and the other not. This showed a saving over and above scheme implementation of approximately one casualty per year per site for those schemes. which had been audited. At an average cost per casualty of £28,100 at 1994 prices (£55,650 per injury accident) the economic benefits would be well in excess of the audit cost for these small schemes. For larger schemes the potential saving in casualties is likely to be substantially greater. ***On most schemes, the prevention of only one injury accident will produce a positive economic benefit.***

Some estimates of the overall benefits of safety audit practice to an organisation have also been made. In Lothian (which has about 3000 injury accidents annually) it has been suggested that a 1 percent savings in accidents, worth £1 million, is possible across the region at a resource cost of £70,000 - a benefit:cost ratio of 14:1. In New Zealand a potential benefit:cost ratio of 20:1 has been estimated for consistent safety audit procedures."

I enclose a copy of the Surrey report. The second paragraph is gleaned from Austroads!

All good wishes
Yours sincerely

Barbara

INTERNAL MEMO

FROM: Alan Dixon - A.N.C.A.I.M.

TO: G.M.S.S, S.T.E. D.M.R.T.S. - (AUCK), (WGTON) & (CHCH)

DATE: 31 March 1993

SUBJECT: Benefit/Cost of Road Safety Audit

BENEFIT/COST OF ROAD SAFETY AUDIT

At the District Managers meeting held on the 3rd March I reported on the current progress of the Safety Audit Working Party and the future role of the M.O.T./L.T.A. in Safety Audit was discussed.

I was asked to report on what the B/C of Road Safety Audit was. I have looked through several papers and found one by Mike Goodge on this topic. He prepared two papers for the "Austroads Road Safety Audit Project" and his second report is titled 'Benefits and Costs of Road Safety Audit' and I enclose a copy for each of you.

An estimate of the potential accident savings is referred to in the last paragraph of page 4 and the first two paragraphs on page 5. If we take Barbara Sabey's estimate of 5% this would translate to 608 accidents or $141,600,000 in N.Z. terms. The view of the U.K. Department of Transport can be seen on pages 5 and 6. It is my view that we should adopt a similar philosophy and include a reference to, Safety Audit in the "Land Transport Plan". Other views on the benefits and of a Safety Culture are mentioned on pages 7 & 8.

The 'Costs' of Audit are referred to on pages 9 and 10. By far the major cost is in man hours and estimates are made for the various stages of Audit. Ian Appleton is currently addressing this problem. The trail audits that have been carried out are being used to get a feel for what might be a reasonable duration for the various stages of audit and hence the costs in Man hours. He will also be looking at how many schemes per year, it will be practicable to Audit considering the shortage of suitably experienced personnel. It is therefore not yet possible to give a realistic B/C.

However, to give us some feel for a possible value I have made the following "guesstimate".

If we say the number of schemes that we will audit per year at Maximum is 1000.

Then if 1000 = 5% Accident Reduction.
In first year say 200 schemes = 1% Accident Reduction
In 1991 there where 12,162 Injury Accidents
1% represents 120 Injury Accidents
If we take an average cost of $236,000/Accident
1% reduction = $28,320,00

Using D.Tp estimate of 10 man/days per Audit
Say 70 man hrs per scheme

Costs/hr $100
Cost = $7,000/Audit

Cost: 200 scheme = $1,400,00

$$B/C = \frac{28,320,000}{1,400,000} = 20.2$$

B/C = 20:1

This just happens to be the B/C that we are currently quoting for Low Cost Accident Remedial measures.

Since from my recent experience of Safety Audit many of the recommendations are of a similar nature to those in A.I. I feel that this B/C is in the right area.

M. L. (Mike) Gadd *C.Eng., MICE, FIPENZ, Registered Engineer.*
Civil and Transportation Engineer, 2/63 Rountree Street Christchurch 4 New Zealand.
tel/fax 64 (0)) 349 - 3710, Mobile 025-376-325

Ms Sarah Mulligan or Ian Ransom
Casualty Reduction Group
Surrey County Council
Room 365
County Hall
Kingston Upon Thames
Surrey KT1 2DN
ENGLAND

7 May 1996

Dear Ms Sarah or Mulligan or Ian Ransom

Benefits of Safety Audit

I have been briefed by Dr Ian Appleton, Safety Audit Manager, Transit New Zealand, to carry out research on the benefits of Safety Audit.

While there are numerous documented safety audits and several papers on the topic including descriptions of the assumed benefits of safety audit, there are very few actual studies which describe actual research or quantify actual benefits. In addition, while the main aim of safety audit is to improve designs from the safety point of view, there may be benefits in other areas (eg. greater adherence to standards, flow on effects in the improvement of designs which are not safety audited, greater awareness of safety issues generally etc.)

As well as setting up a study to determine crash savings at audited sites v. non-audited sites, we are interested in setting up a data base.

Ms Barbara Sabey kindly sent me a copy of your report: ROAD SAFETY AUDIT - Investigation into casualty savings.

At the foot of page 2 the offer of further information and your names appears. I have been tasked to investigate the creation of a data base and methodology for determining the benefits of safety audit. I would be grateful if you could provide information on your project.

Firstly, there is the data base - "WINGS" - which could have application here (and save me a lot of time!). Is this data base of your own creation (or the DoTP?) and are you able to assist me in any way? I say "any way" because you might be reluctant to release the software. It would be useful to me, however, if you could describe what data is handled and what outputs are sought. Are there any conditions we could comply with to get a copy? I realise I am "jumping the gun" a little as the programme might not apply in New Zealand. I would have to discuss the matter with my client, but assuming it is applicable here and would save time and effort we could be interested in purchasing the software. On the other hand, if the programme makes use

of a relational data base (such as "Access") it may be relatively easy for us to set up our own. I apologise for jumping in like this but it could save correspondence if I canvass the possibilities here.

The Land Transport Safety Authority in New Zealand maintains records of reported injury and non injury collisions which form the basis of justification of accident-reducing road schemes and are a component of all B/C calculations. However, the data is not set up to monitor specific sites, though it could possibly be interrogated.

Secondly, the study and your methodology are very interesting, being one of the few examples of an attempt to calculate benefits of safety audit. It seems to me that the number of sites included in both the audited and non-audited fields is on the small side, and you state with confidence that two years after data is OK. Have you applied any statistical tests to the data and conclusions? I don't want to be a "wet blanket" however and I'm sure the deductions are basically sound.

Any information you can give me will be appreciated. No doubt as the annual reports get done the confidence in the results will grow. I don't see a precise date on your report and it may well be that another is due. Could you send me a copy when it eventuates?

In turn, if you would like a copy of our research I will be happy to send one - when completed of course. I do have some information on the frequency of topics being raised and enclose an extract from a recent report.

I look forward to hearing from you.

Yours sincerely

M. L. (Mike) Gadd